Appendix I — Water Management Plan

The following section describes the requirements for a Water Management Plan, which is needed for individual coal bed methane (CBM) well APDs or multiple well PODs. Additional technical support information for WMPs is currently being developed by BLM as part of the revision of the *Buffalo Field Office CBM APD and Project POD Preparation Guide.*

The operator shall provide a comprehensive water management plan (WMP) that addresses the handling of produced water during the testing and production of coal bed methane (CBM) well(s). The WMP must provide adequate information for the BLM to complete NEPA analysis and to ensure compliance with all state and federal requirements prior to approval. A CBM APD/POD will not be considered complete or processed by BLM unless it contains a WMP.

REQUIREMENTS FOR WMPS:

1. The WMP must include a statement that the operator will comply with all laws, standards and criteria set forth by all appropriate Federal, State and Local authorities including Wyoming State Engineers Office (WSEO), Wyoming Department of Environmental Quality (WDEQ), Wyoming Oil and Gas Conservation Commission (WOGCC), BLM, Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (Corps).

2. The WMP will be submitted concurrently as an addendum to the APD/POD or as a section within the POD Surface Use Plan under item No. *12. Other Information*.

3. A WMP map will be required. For the map identify discharge points, watershed boundaries, reservoirs, infiltration pits, low water crossings, head-cuts and other erosion features, land application disposal areas, water and gas pipelines, spring locations, wells, roads, POD boundary, and other info necessary to adequately evaluate the WMP.

    - Submit Four copies of the Water Management Plan Map. If changes are made as a result of the onsite or because of operator revisions, four copies of each of final maps will be required.
    - For smaller PODs or where clutter is not an issue, maps may be combined into one master map (four copies needed)

4. A representative water quality analyses, performed within the last six months, will be included for each targeted coal zone on lease. Samples should be from the closest source possible within the Township and Range of the proposed action (maximum distance 6 miles).

    Constituents analyzed in the water quality analyses will be the same as those required by the Wyoming Department of Environmental Quality (DEQ) for the National Pollutants Discharge Elimination System (NPDES) permit using approved Environmental Protection Agency (EPA) test procedures (40 CFR 136 or 40 CFR136.5). The list of constituents and detections limits can be found following in Appendix WMP 1.

    The first well drilled to each targeted coal zone will become the designated reference well. Designated reference wells must have the ability to be sampled at the wellhead. Water samples will be collected for analysis within 30-60 days of initial pumping. Results of the analysis will be submitted to the BLM Authorized Officer as soon as they become available.

5. Plans and designs for the erosion control and stabilization measures for minor head-cuts, eroding channel sections, etc., must be provided. In-channel mitigation measures must be designed to

accommodate existing and proposed discharges, in addition to naturally occurring flow. Engineering diagrams for erosion control and stabilization measures for major areas of improvement will be required, at BLM's discretion, on a site-specific basis. BLM may require notification prior to any activity crossing a waterway of the state, in order to ensure compliance with USCOE General Permit 98-08.

6. All WMPs must include a Lessee's or Operator's Representative and Certification as follows:

   I hereby certify that I, or persons under my direct supervision, have inspected the watershed area(s) affected by our coal bed methane drilling and production plans; that I am familiar with the conditions which currently exist; that the statements made in this plan are, to the best of my knowledge, true and correct; and that the work associated with operations proposed herein, including construction, monitoring and reclamation activities will be performed by _____ and its contractors and subcontractors in conformity with this plan and the terms and conditions under which it is approved. This statement is subject to the provisions of 18 U.S.C. 1001 for the filing of a false statement.

   Date _____Name and Title_____

   If the WMP is prepared by the same entity and submitted as part of the POD Master Surface Use Plan or APD Surface Use Plan, then the Certification Statement already required under APD Item 13 of the Surface Use Plan will suffice.

7. A completed *Hydrologic Watershed Field Analysis Summary Sheet* for <u>each</u> watershed evaluated for the POD area will be submitted with the WMP. This information must be based on field reconnaissance and must include the following:

   a. Watershed area
   b. Average watershed slope
   c. Existing channel (average slope, width, depth, condition, etc.) and calculation of mean annual flow
   d. Peak flow analysis (2-, 10-, and 25-year return interval at a minimum)
   e. Destination (i.e., tributary to the Belle Fourche River)
   f. Description of the existing watershed including:
      i) Existing wells (location, depth, water level, use, condition)
      ii) Existing impoundments (location, size, volume, use, condition, description of outlet works and spillway)
      iii) Road crossings (crossing type - culvert, low water crossing, bridge, etc. and condition)
      iv) Water related uses (irrigation, livestock, industrial uses, etc.)
      v) Potential down stream concerns (on- channel impoundments, hay meadows, coal mine reclamation and sediment structures, unimproved channel crossings, etc.) and plans to mitigate impacts caused by discharge of produced water.

Hydrologic Watershed Field Analysis Summary Sheet

POD Name: **Company:** **Watershed involved** **Watershed Area :**
Average Watershed Slope, ft./mi.:
Existing Channel information
Average Bank Full Width, ft.
Average Channel Slope, feet/foot
Average Channel Width, ft. and Depth, ft.
General Channel Condition: Stable/Unstable (potential erosion areas of concern)
Proposed Channel Improvements
Area of Headcut Modification, square feet: acres:
Area of Pipeline or utility corridor channel crossing, square feet: acres:
Area of Low Water Crossings, square feet: acres:
Area of other channel modifications (describe by type): acres:

Channel Vegetative Cover/ Dominant Species:

Peak Flow Analysis (Describe methods used for calculations and provide values used as variables)

Recurrence Interval (Years)	**Exceedence Probability(%)**	**Peak Flow**	**Peak Flow for Complete Basin (CFS)**
2	**50**		
5	**20**		
10	**10**		
25	**4**		

8. Include in either the WMP or item # 3 of the surface use plan for the POD, a list of all the wells permitted through the WSEO within a one-mile radius of the producing wells and water management structures in the project area.

9. A table listing the culverts (existing and proposed) in the development area, including the location (GPS coordinates (Latitude/Longitude, or Northing/Easting)), size (diameter and length), area of in-channel disturbance, drainage area above the culvert, condition of existing culverts and the anticipated maximum flow, including CBM discharge, through the culvert based on a 10-year flood without development of static head at the entrance.

10. A table listing the low water crossings (existing and proposed) in the development area, including the location (GPS coordinates (Latitude/Longitude, or Northing/Easting)), area of in-channel disturbance, drainage area above the crossing and the anticipated maximum flow, including CBM discharge, through the crossing based on a 10-year flood.

11. A table listing the CBM water discharge points (existing and proposed), including location (GPS coordinates (Latitude/Longitude, or Northing/Easting)), all wells contributing to discharge at each point, estimated maximum flows, and NPDES number as available. Access routes to discharge points must be described in the project WMP and identified on the map.

12. A table listing the headcuts, sidecuts or other erosional features in the development area, including the location (GPS coordinates (Latitude/Longitude, or Northing/Easting)), size (diameter and length), area of in-channel disturbance, and proposed mitigation.

13. A table listing reservoirs (existing and proposed), including the location, capacity, embankment-height, top width, crest length, upstream and downstream slope, condition, description of low-level outlet (agri-drain), spillway, hydrologic characteristics and an accounting of the disturbed area. Access routes to reservoirs must be described in the project WMP and identified on the map.

14. If part of the water management strategy includes Land Application Disposal (LAD), additional information regarding the site location, application rate and method, soil chemistry and characteristics, and monitoring program will be required. For additional information, refer to the Land Application Guidance in Appendix WMP 3.

15. The description of the proposed maintenance and monitoring program. Include monitoring frequency and maintenance plans for discharge points, reservoirs, culverts, channel crossings, other water control structures, erosional features (including headcuts) and stream channels. Additional information regarding a monitoring plan is found Appendix WMP 4.

16. All potential downstream concerns or impacts will be identified, documented and mitigation proposed.

17. Prior to abandonment of facilities associated with the WMP, the operator will submit, via Sundry Notice (Form 3160-5) site-specific reclamation plans for BLM review and approval. Phased reclamation (i.e., reclaim individual facilities as they are no longer necessary) will be expected. Any activities outside the approved proposed actions will require authorization by the BLM Authorized Officer.

18. Some investigations required for WMP preparation may require on-site data collection for the proposed project area. Operator should contact the Buffalo Field Office of the BLM for authorization prior to commencement of any activities associated with data collection.

19. Documentation that all proposed new and modifications to existing on-channel CBM water containment structures will be done in conformance with and are properly permitted (or are in the process of being permitted) through the WSEO (and the USCOE if necessary). If the structure is on Federal surface, it must also meet criteria set forth by the BLM State Engineer. For additional guidance regarding on-channel containment structures, please refer to Appendix WMP 4.

20. Documentation that all proposed off-channel CBM water containment structures meet the siting criteria as outlined in the Guidelines for Off-Channel CBM Water Containment Structures located in Appendix WMP 5. If the structure is constructed on Federal surface, it must also meet design criteria set forth by the BLM State Engineer.

21. A bond will be required for each off-channel water containment structure associated with a Federal Lease, the details of which will be based on site-specific conditions.

22. Operators will be requested to submit project maps electronically using geographic information system (GIS) software.

General Guidance

- Consult private surface owner(s) early in the planning process and throughout the development of water management plans WMPs.
- Develop WMPs on a sub-watershed basis, coordinating with other companies within the same sub-watershed.
- Consider all upstream contributions (natural flow, runoff and other discharges) and determine through sound hydrologic analysis if the produced CBM water from the wells (based on known or anticipated water production rates) will adversely impact downstream improvements, uses, and users (reservoirs, hay ground, etc.).
- Depending on the water quality and quantity, it may be beneficial to consider centralizing the water discharge to localize the associated disturbance.
- Consider innovative methods of using produced CBM water. Any method recommended will be evaluated and authorized on a case-by-case basis.
- Locate discharge points and reservoirs in readily accessible areas for ease of installation and monitoring. Also, consider access options which involve the least surface disturbance in any erosion feature modification design.
- Select designated reference well locations so that they will be easily accessible year-round for sampling.

Discharge Points

- Locate discharge points in areas that will minimize erosion and impacts to the receiving channel, existing improvements, and downstream users.
- Do not locate discharge points on hilltops or upland areas unless diecharge is to an approved water containment structure. Insure that they are located in stable, low gradient drainage systems and below active head cuts.
- Locate discharge points below any potentially active headcuts whenever possible. If discharge must be made above a headcut, mitigation will be required by the BLM Authorized Officer, including engineered remediation on a site-specific basis.
- Design proper energy dissipation measures for discharge outlets (e.g., vertical culvert with rip-rap, splash pad, laydown pipe with French drain on rip-rap pad, etc.)
- Discharge locations will not be authorized by BLM unless they are in an environmentally sound location, regardless of NPDES status or previous use. Sites may be moved or otherwise mitigated by the BLM Authorized Officer during onsite inspections where environmental issues exist.

- Cumulative produced water discharge must not exceed the naturally occurring mean annual peak flow of the receiving channel.
- Do not locate discharge points in playas or enclosed basins unless it can done in an environmentally sound manner without resulting in adverse impacts. Discharges into valley bottoms with no defined low-flow channel will generally not be authorized, but will be reviewed on a site-specific basis.
- Minimize channel disturbance as much as possible by limiting pipeline and access crossings. Avoid running pipelines and access roads within floodplains, parallel to the channel.

Water Containment Structures

- Reservoirs must be designed in accordance with WSEO standards to accommodate the proposed as well as potential upstream development. For on-channel reservoirs, refer to the guidance located in Appendix WMP 4.
- Locate off-channel pits so that there will be no negative impact on the adjacent surface, surface water or groundwater. Refer to Appendix WMP 5.
- Discharges to existing and proposed impoundments must be in compliance with all WSEO, COE and BLM requirements.
- Reservoirs: See Appendix 4 and 5 in the following section for specific guidance regarding both on-channel reservoirs and off-channel pits.
- If passage of water through a spillway is to be frequent, the spillway must be reinforced and designed for continual flow (regular flows on earthen spillways will not be allowed).

Appendix WMP 1 – Water Quality Analysis Criteria

Constituent	Detection Limits
Expected Flow volume from each well:	gallons per day
Total dissolved solids:	5 mg/l (milligrams per liter)
pH:	0.1 standard units
Sulfates:	10 mg/l
Chlorides:	5 mg/l
Specific conductance:	5 micromhos/cm
Total radium 226:	0.2 pCi/l (picoCuries/liter)
Total petroleum hydrocarbons[1]:	1 mg/l
Total[2] Aluminum:	50 µg/l (micrograms per liter)
Total Antimony:	5 µg/l
Total Arsenic:	0.1 µg/l
Total Barium:	100 µg/l
Total Beryllium:	0.03 µg/l
Dissolved[3] Cadmium:	0.1 µg/l
Dissolved Chromium:	1 µg/l
Dissolved Copper:	1 µg/l
Total Cyanide:	5 µg/l
Dissolved Iron	30 µg/l
Dissolved Manganese:	10 µg/l
Dissolved Nickel:	10 µg/l
Dissolved Lead:	2 µg/l
Dissolved Mercury:	0.06 µg/l
Phenol:	10 µg/l
Total Selenium:	5 µg/l
Dissolved Silver:	3 µg/l
Total Thallium:	10 µg/l
Dissolved Zinc:	10 µg/l
Total Hardness:	10 mg/l as $CaCO_3$
Dissolved Sodium:	1 mg/l
Dissolved Magnesium:	1 mg/l
Dissolved Calcium:	1 mg/l
Dissolved Boron:	0.1 mg/l
Bicarbonate:	1 mg/l
Dissolved Fluoride:	0.1 mg/l
Dissolved Potassium:	1 mg/l
Total Alkalinity:	1mg/l as $CaCO_3$
Sodium Adsorption Ratio:	not applicable

[1]Acceptable methods for analyzing total petroleum hydrocarbons are 418.1 in the latest edition of Standard Methods for the Examination of Water and Wastewater and EPA SW846 Method 8015 (modified) for Total Extractable Petroleum Hydrocarbons.

[2] Value is expressed in terms of total recoverable metal in the water column.

[3] Volume is based on the dissolved amount, which is the amount that will pass through a 0.45 µm filter prior to acidification to pH 1.5 - 2.0 with nitric acid.

NOTE: Except for the aquatic life values for metals and where otherwise indicted, the values given refer to the total recoverable (dissolved plus suspended) amount for each substance. For the aquatic life values for metals, refer to the dissolved amount.

Appendix WMP 2 – Monitoring Plan Requirements

Monitoring Plans must include the following as a minimum:

- The operator will be responsible for monitoring discharge point(s) on a monthly basis for the first year of operation. Inspectors will note the condition of each discharge point, check for evidence of erosion, and schedule any necessary mitigation work. Records of the inspections will be made available to the BLM Authorized Officer upon request.

- Dam outlets (spillways and pipes) and culvert outlets will be inspected quarterly, or after major storm events for the first year of operation. Inspectors will note the condition, check for evidence of erosion, and schedule any necessary mitigation work. A reservoir maintenance program will be included to address storage capacity management. Records of the inspections will be made available to the BLM Authorized Officer upon request.

- Erosion stabilization measures (head cut repairs, etc.) will be inspected on a monthly basis for the first year of operation, for signs of erosion or structure failure. Inspectors will note condition and schedule any necessary mitigation work. Records of the inspections will be made available to the BLM Authorized Officer upon request.

- Downstream channels (below the well(s)/project area) will be inspected on a monthly basis for signs of accelerated erosion due to the continuous flow of produced water for the first year of operation, which includes low water crossings. Records of the inspections will be made available to the BLM Authorized Officer upon request.

- Any mitigation work, repairs or other maintenance which involves actions or surface disturbance outside the scope of the initially authorized action will require approval by the BLM Authorized Officer prior to the initiation of any work. The proposed actions will be submitted as a Sundry Notice to the Buffalo Field Office of the BLM.

- An access agreement for BLM monitoring will be included with the WMP for the lease area.

- After the first year of operation, inspections will occur annually unless specific sites have required mitigation action, then inspections will continue at the previous intervals until no action has been required for a full year. Records of the inspections will be made available to the BLM Authorized Officer upon request.

Appendix WMP 3 – Land Application Disposal Guidance

The consideration of LAD as a beneficial use of CBM produced water can only be determined after an extensive evaluation of the land application operation has been completed. Many environmental factors must be assessed to determine both the potential risk and potential benefits for land application to be considered a viable option for disposal of discharge water. The best management practices for land application will be an evolving process as new research, data, and processes become available. The operator is strongly encouraged to consult with the BLM specialists early in the development of the water management plan.

Land application disposal of produced water has the potential to produce negative, long term impacts to soil physical and chemical properties if not properly managed. Proposals to land apply CBM produced water of federal projects must include the following.

1. Site selection: Should include a general description including, but not limited to, slope, aspect, elevation and local climatic limitations. Detailed existing vegetation composition and canopy cover by species, percent bare ground, and any erosion or soil compaction features.

2. Site Characterization: The site characterization must include comprehensive field investigations of soils and vegetation. The site will be described in detail and soil samples will be collected and analyzed to determine important soil chemical and physical properties. Site descriptions should include maps, vegetation descriptions, detailed soil profile descriptions, laboratory analysis and location of proposed application disposal sites. Photo documentation of the site should be included. Laboratory analysis of the produced water should also be included with the site characterization study.

3. Project description: The project description must include the proposed method(s) of water application disposal, application rates and schedules and physical layout of application disposal areas. Complete maps of the application infrastructure should be included. Detail any soil or water amendments which will be utilized or physical soil manipulation which are planned. Project descriptions should demonstrate that land application disposal is feasible given the results of the site characterization.

4. Monitoring Plan: Periodic monitoring of soils and vegetation will be required to assure that negative impacts are not occurring or are being remediated. Monitoring must include soil sampling and laboratory analysis.

5. Winter Operations: Detail Practices which will be used to prevent the buildup of ice on the soil surface during sub freezing temperatures.

6. Mitigation Plan: A plan must be developed which outline mitigation measure which will be implemented in the event negative soils or vegetation impacts are deleted during routine monitoring. Potential mitigation measures might include soil or water amendments, physical manipulation or vegetative treatments.

These criteria are general in nature, and must be adjusted to site specific conditions. Detailed soil sampling criteria have not yet been developed, so project proposals will be evaluated on a case by case basis during the interim.

The effectiveness of a LAD system will depend on many things including. The soil types involved and there associated physical and chemical properties. The method of application will help identify the site, water delivery efficiency, leaching requirements and surface salt accumulations. The water quality of the CBM produced water will determine the feasibility of application but also the predicted environmental effects as well as determine the effectiveness of chemical and organic amendments need for mitigation.

Appendix WMP 4 - On-Channel CBM Water Containment Structures

For on-channel CBM water containment structures on BLM surface lands that are proposed as part of the WMP, the operator must provide the following information for review by the BLM State Engineer:

1. For each on-channel (CBM) water containment structure smaller than 20 acre-feet capacity and with a dam height of less than 20' (20/20), the operator must include in the WMP the information that would normally be required by the SEO for a stock water reservoir permit. This information would need to clearly show that each on-channel CBM water containment structure is being constructed using BLM specifications for earthwork placement and principle spillway configuration. After a case-by-case consideration of the factors below (a. and b.), BLM would either approve or disapprove each on-channel CBM water containment structure. Upon approval by the BLM, the operator would then need to have each on-channel CBM water containment structure permitted by the SEO.

2. For on-channel (CBM) water containment structures greater than 20/20, the permit application must be submitted to the BLM as part of the WMP with the information that would be normally required for permitting by the SEO. If approved by the BLM State Engineer at the Wyoming State BLM office, the operator would then be required to submit an application to the SEO for approval under the Safety of Dams program.

   On-channel CBM water containment structures on BLM surface will be approved or disapproved on a case-by-case basis after considering the following factors:

   a. Proper siting and design.
   b. Existing resource uses/needs and multiple-use management principles.

   Please be advised that BLM will apply special *Conditions-of-Approval* to authorized on-channel CBM water containment structures depending upon case-by-case consideration of the above-factors. Construction monitoring by BLM Authorized Officers would also be required on a case-by-case basis.

3. Water production rates (for each discharge point and CBM flows into the water containment structure) must be disclosed including discharge schedule (initial, intermediate, and final rates and duration) and maximum, mean, and minimum anticipated rates.

Appendix WMP 5 - Off-Channel CBM Water Containment Structures

Guideline approved by Water and Waste Advisory Board Page 1
October 1, 2002
Wyoming Department of Environmental Quality
Water Quality Division
August 6, 2002
"Off-channel, Unlined CBM Produced Water Pit
Siting Guidelines for the Powder River Basin, Wyoming"

BACKGROUND AND OBJECTIVES

The WDEQ/Water Quality Division has worked with other state and federal agencies to develop recommendations to be implemented through various regulatory mechanisms for evaluating and siting CBM produced water pits. The recommendations call for CBM operators to collect hydrogeologic information at each site to determine the following:

1) The classification of shallow, unconfined groundwater (where present) as determined from existing use or ambient quality, or both, in accordance with Chapter 8 of WDEQ's Water Quality Rules and Regulations.
2) Ability of the produced water to diminish the use (i.e. suitability) of shallow, unconfined groundwater (where present).
3) Ability of the produced water to re-surface, or reach surface waters.
4) Ability of the produced water pit to infiltrate into the subsurface.

The evaluation of the placement of the unlined CBM produced water pits should be conducted before the construction of the pits. Any questions about the final placement of the unlined CBM produced water pits should be clarified with the WDEQ/WQD before submitting a permit application to the WDEQ/NPDES program or Wyoming Oil and Gas Conservation Commission.

In addition to the evaluations listed below, more information and assessment may be needed when attempting to evaluate potential impacts from large (e.g. $ 5 acres) or deep infiltration pits, or pits proposed in potentially vulnerable areas. Examples of these areas would include: environmentally sensitive areas such as wetlands, areas with multiple domestic wells such as a rural subdivision, wellhead protection or source water protection areas, and areas near public drinking water supply wells. In some situations, monitoring programs may be needed to measure and assess the movement and fate of leachate from infiltration pits and/or the effects, if any, upon groundwater and surface water quality. Where unlined pits cannot be allowed operators should consider the use of alternative disposal methods. Surficial geology data on the Powder River Basin is available from the Wyoming State Geological Survey and will aid in siting unlined CBM produced water pits.

PROXIMITY TO "SURFACE WATERS OF THE STATE"

Discussion:

Surface waters of the state means all perennial, intermittent, and ephemeral defined drainages, lakes, reservoirs and wetlands which are not man-made retention ponds used for the treatment of municipal, agricultural or industrial waste; and all other bodies of surface water, either public or private, which are wholly or partially within the boundaries of the state as defined in Water Quality Rules and Regulations, Chapter 1 Because the off channel produced water pits may be allowed to leak into the subsurface, there must be reasonable assurance that there is no direct subsurface hydrologic connection between the produced water pits and surface waters of the state.

In order to protect the surface waters of the state, produced water pits should be located one-quarter mile (1320 feet) from the outermost alluvium (and adjacent mixtures) of any current stream system and, at a minimum, five hundred (500) feet from the edge of any bank-to-bank stream channel, pond, reservoir, wetland or lake.

Note: 1:100,000 scale surficial geology maps produced by the Wyoming State Geological Survey and the USGS are available for some areas of the Powder River Basin (see attached list) and are to be used in

identification of alluvial deposits. In unmapped areas alluvial deposits must be identified by field investigation. USGS 1:24000 scale topographic maps can be used to aid in determining off channel pit locations. Solid blue lines illustrate perennial streams; dashed blue lines illustrate intermittent streams. Ephemeral streams are not uniquely defined on USGS topo maps, however, major ephemeral drainages are included with the intermittent drainages. The dashed blue lines may suffice for illustrating ephemeral streams with a bank to bank channel; however, additional field investigation may be necessary to determine if the map symbol accurately depicts field conditions. For any pit proposed to be located within one-quarter mile (1320 feet) from the outermost alluvium (and related mixtures) of any current stream system and/or within five hundred (500) feet from the edge of any bank-to-bank stream channel, pond, reservoir, wetland, or lake evidence should be presented that demonstrates that there will be no direct hydrologic connection from the unlined CBM produced water pit to surface waters of the state, or to areas outside of the pit. The evidence may be in the form of a subsurface investigation, modeling that utilizes site specific parameters, or other evidence (e.g., groundwater gradient) that protects surface waters of the state.

PROXIMITY TO DOMESTIC WATER SUPPLY WELL (PROTECTION OF GROUNDWATER WHERE THERE IS DOMESTIC USE)

Discussion:

Groundwater is classified by either the current use (i.e. domestic, agricultural, livestock, etc.) or the ambient quality of the groundwater (where there is no use). Where groundwater is being used for domestic purposes it will be protected to Class I standards. That is, concentrations of inorganic, metal, and other analytes within the groundwater must remain within the domestic class of use suitability standard. Groundwater can be Class I "by use" even when concentrations of one or more analytes within it exceeds Class I suitability standards. In this case, concentrations of analytes within the groundwater cannot exceed the domestic class of use suitability standard unless the ambient concentration is greater than that standard. For those analytes whose ambient concentrations are less than the domestic class of use suitability standard, limited degradation is allowed but only to the point that concentrations do not exceed the standard. Groundwater classifications are discussed in Water Quality Rules and Regulations, Chapter 8.

Unlined CBM Produced Water Pits Located Within 1/4 Mile of Any Domestic Use Well:

In order to provide protection for an aquifer that is currently being used for a domestic water supply, the department recommends that the operator should not attempt to locate an unlined CBM produced water pit within 1/4 mile of a domestic use well. If an unlined CBM produced water pit is to be located with 1/4 mile of a domestic use well, the following information should be developed:

1) The operator should demonstrate that the water quality being discharged into the unlined CBM produced water pit is of equal or better quality than the groundwater being utilized in the domestic use well. (Please see discussion above regarding groundwater class of use and protection.)
2) The operator should demonstrate that the domestic use well will not be impacted (i.e., the domestic use well is located upgradient or cross-gradient from the unlined CBM produced water pit) and that the class of use of groundwater will not be impaired.
3) The operator should demonstrate that the aquifer in which the domestic use well is screened is of sufficient depth or confinement such that any water infiltrating from the unlined CBM pit will not reach the aquifer. Information about the construction details of the domestic use well should be presented to ensure that a proper annular seal exists to prevent vertical migration of water down the well bore.

If none of these three conditions can be met, the unlined CBM produced water pit should not be located within 1/4 mile of a domestic use well.

PROXIMITY TO STOCK AND IRRIGATION WELLS (PROTECTION OF GROUNDWATER WHERE THERE IS NON-DOMESTIC USE)

Discussion:
In order to protect groundwater that may be suitable for domestic use, any stock and irrigation well that is within 1/4 mile of the produced water pit shall be sampled for Table 1 parameters in order to determine ambient quality of the shallow aquifer, unless it can be shown by State Engineer's Office records or field measurements that the well is not completed within the shallow aquifer.

Groundwater from stock and irrigation wells may be classified as Class I (i.e., domestic) by ambient quality and must be protected as such. If the groundwater is designated as Class I by ambient quality, the recommendations of the following section on siting pits within areas of potentially high quality groundwater should be applied.

If the ambient quality of the groundwater from a non-domestic well is equal to, or less than the quality of the CBM produced water, no restrictions would apply.

LOCATION OF PITS WITHIN AREAS WITH POTENTIALLY HIGH QUALITY SHALLOW AQUIFERS (PROTECTION OF GROUNDWATER WHERE THERE IS NO USE)

Discussion:
*In order to protect groundwater that may be suitable for domestic use, where a CBM produced water pit is proposed to be located within areas where Total Dissolved Solids (TDS) concentrations of groundwater within the Wasatch/Fort Union formations are depicted as < 500 mg/L, the groundwater shall be sampled for Table 1 parameters in order to determine ambient quality of the shallow aquifer.**

If the groundwater is designated as Class I by ambient quality an unlined CBM produced water pit may be allowed if it can be demonstrated that the water quality being discharged into the unlined CBM produced water pit is of equal or better quality that the groundwater.

If this condition cannot be met, the unlined CBM produced water pit should not be located within that area, or an acceptable, alternative disposal method used. If the ambient quality of the groundwater is equal to or less than the quality of the CBM produced water no restrictions would apply.

- **Note:** WDEQ recommends the use of *Dissolved Solids Map of Wasatch/Fort Union Aquifer System Water, Powder River Basin, Wyoming* from Volume I-B, *Occurrence and Characteristics of Ground Water in the Powder River Basin, Wyoming*, Water Resources Research Institute, University of Wyoming, 1981. An updated, similar map is currently under development by the Wyoming State Geological Survey and USGS and should be used when completed.

PROXIMITY TO CLINKER/SCORIA DEPOSITS

Discussion:
Large clinker deposits are present in various areas of the Powder River Basin. The clinker deposits can be a highly permeable deposit with high groundwater flow velocities due to fracture flow. Clinkers deposits are known to contain high quality aquifers in some areas. 1:100000 scale surficial geology maps illustrating locations of clinker deposits are available from the Wyoming State Geological Survey. Site specific analysis may be needed in potentially vulnerable areas.
In order to protect groundwater and surface water quality, no unlined pit should be located on or within 500 feet of a clinker deposit without consideration of the following information:

1) Analysis of the clinker groundwater aquifer or any existing springs associated with the clinker should be classified according to Table 1 groundwater parameters and;
2) Surface and subsurface extent of clinker deposit, groundwater flowpaths, and the ability of infiltrated pit water to migrate to "surface waters of the state".

Pits can be located on a clinker deposit or within 500 feet of a clinker deposit only if:

1) Analysis of groundwater demonstrates that the aquifer is of equal or lesser quality than the CBM water discharged into the pit, **and**
2) It can be demonstrated that the water infiltrating through the clinker will not reach "surface waters of the state".

PROXIMITY TO SPRINGS

Discussion:
Springs shall be afforded the same protection as groundwater. In order to protect waters of the state, no produced water pit should be sited within 1/4 mile of any spring unless the following can be documented:
1) The water quality of the spring is determined to be of equal or lesser quality than the CBM water being discharged into the pit. This determination is based upon groundwater classification parameters in Table 1; or
2) The spring is determined to be up-gradient or cross gradient from the pit.

If a pit is to be placed within 1/4 mile of a spring that has been determined to be of better quality water than the CBM discharge water evidence must be presented to demonstrate that the spring will not be impacted, or a monitoring program approved by WDEQ must be implemented.

Table 1: Classification Analytes1

Arsenic	Calcium	Chromium	Iron
Fluoride	Barium	Sodium	Lead
Cadmium	pH	Boron	Chloride
Potassium	SAR2	Sulfate	Dissolved Solids
Magnesium	Total Selenium	Copper	Zinc

1 The listed parameters shall be analyzed in the laboratory for "total" concentrations.
2 Sodium Absorption Ratio (SAR): SAR is a calculated number involving the ratio of sodium, calcium and magnesium ions. The number is derived to predict the degree to which irrigation water tends to enter into cation exchange reaction with soil. High values of SAR can be damaging to soil structure. The Class II (agricultural) standard for SAR is eight (8). There is no Class I (domestic) or Class III standard for SAR. Therefore, if the producing groundwater is classified as a Class I or Class III aquifer, the concentrations of sodium, calcium, and magnesium (components of SAR) will not be allowed to degrade an underlying Class II aquifer beyond its class of use.

WYOMING STATE GEOLOGICAL SURVEY GEOLOGIC HAZARDS SECTION DIGITAL MAPS (HSDM)

PUBLISHED DIGITAL SURFICIAL GEOLOGIC MAPS
HSDM 98-1 Preliminary 1:500,000-scale digital surficial geology map of Wyoming
HSDM 98-3 Preliminary digital surficial geologic map of the Casper 30' x 60' Quadrangle, Natrona and Converse Counties, Wyoming
HSDM 98-4 Preliminary digital surficial geologic map of the Cheyenne 30' x 60' Quadrangle, southeastern Wyoming, western Nebraska, and Northern Colorado
HSDM 98-5 Preliminary digital surficial geologic map of the Laramie 30' x 60' Quadrangle, Albany and Laramie Counties, Wyoming
HSDM 98-6 Preliminary digital surficial geologic map of the Rawlins 30' x 60' Quadrangle, Carbon and Sweetwater Counties, Wyoming
HSDM 99-2 Preliminary digital surficial geologic map of the Douglas 30' x 60' Quadrangle, Converse and Platte Counties, Wyoming

HSDM 99-3 Preliminary digital surficial geologic map of the Powell 30’ x 60’ Quadrangle, Bighorn and Park Counties, Wyoming, and southern Montana

HSDM 99-4 Preliminary digital surficial geologic map of the Rock Springs 30’ x 60’ Quadrangle, Sweetwater County, Wyoming

HSDM 99-5 Preliminary digital surficial geologic map of the Sheridan 30’ x 60’ Quadrangle, Sheridan, Johnson, and Campbell Counties, Wyoming, and southeastern Montana

HSDM 99-6 Preliminary digital surficial geologic map of the Torrington 30’ x 60’ Quadrangle, Goshen and Platte Counties, Wyoming, and western Nebraska

HSDM 00-2 Preliminary Digital Surficial Geologic Map of the Buffalo 30’ x 60’ Quadrangle, Johnson and Campbell Counties, Wyoming

HSDM 00-3 Preliminary Digital Surficial Geologic Map of the Cody 30’ x 60’ Quadrangle, Park County, Wyoming

HSDM 00-4 Preliminary Digital Surficial Geologic Map of the Kaycee 30’ x 60’ Quadrangle, Johnson and Campbell Counties, Wyoming

HSDM 00-5 Preliminary Digital Surficial Geologic Map of the Newcastle 30’ x 60’ Quadrangle, Weston and Niobrara Counties, Wyoming , and Western South Dakota

HSDM 00-6 Preliminary Digital Surficial Geologic Map of the Worland 30’ x 60’ Quadrangle, Big Horn, Washakie, and Johnson Counties, Wyoming

HSDM 01-2 Preliminary Digital Surficial Geologic Map of the Burgess Junction 30’ x 60’ Quadrangle, Big Horn and Johnson Counties, Wyoming, and Southeastern Montana

HSDM 01-3 Preliminary Digital Surficial Geologic Map of the Devils Tower 30’ x 60’ Quadrangle, Crook County, Wyoming, Western South Dakota, and Southeastern Montana

HSDM 01-4 Preliminary Digital Surficial Geologic Map of the Lance Creek 30’ x 60’ Quadrangle, Niobrara and Converse Counties, Wyoming, Southwestern South Dakota, and Northwestern Nebraska

HSDM 01-5 Preliminary Digital Surficial Geologic Map of the Lusk 30’ x 60’ Quadrangle, Niobrara, Goshen, and Platte Counties, Wyoming , and Northwestern Nebraska Guideline approved by Water and Waste Advisory Board Page 6 October 1, 2002

HSDM 01-6 Preliminary Digital Surficial Geologic Map of the Sundance 30’ x 60’ Quadrangle, Crook and Weston Counties, Wyoming, and Southwestern South Dakota

PUBLISHED DIGITAL BEDROCK GEOLOGIC MAPS

HSDM 98-2 Digital geologic map of the Cheyenne 30’ x 60’ Quadrangle, southeastern Wyoming, western Nebraska, and Northern Colorado

HSDM 99-1 Digital geologic map of the Gillette 30’ x 60’ Quadrangle, Campbell, Crook, and Weston Counties, northeastern Wyoming

HSDM 00-1 Digital Geologic Map of the Laramie 30’ x 60’ Quadrangle, Albany and Laramie Counties, Wyoming

HSDM 01-1 Digital Geologic Map of the Sheridan 30’ x 60’ Quadrangle, Sheridan, Johnson and Campbell Counties, Wyoming, and Southeastern Montana

USGS SURFICIAL GEOLOGIC MAPS

The US Geological Survey has published surficial geologic maps for the Recluse 30' x 60' Quadrangle (Reheis and Williams, 1984), the Reno Junction 30' x 60' Quadrangle (Reheis and Coates, 1987), and the Gillette 30' x 60'

Quadrangle (Reheis, 1987). Those maps were slightly modified by the Wyoming State Geological Survey to be consistent with the HSDM surficial map series.

Reheis, M.C., 1987, Surficial geologic map of the Gillette 30’ x 60’ Quadrangle, Campbell and Crook Counties, Wyoming: U.S. Geological Survey Coal Investigations Map C-105, scale 1:100,000.

Reheis, M.C., and Coates, D.A., 1987, Surficial geologic map of the Reno Junction 30’ x 60’ Quadrangle, Campbell and Weston Counties, Wyoming: U.S. Geological Survey Coal Investigations Map C-106, scale 1:100,000.

Reheis, M.C., and Williams, V.S., 1984, Surficial geologic map of the Recluse 30' x 60' Quadrangle, Wyoming and Montana: U.S. Geological Survey Coal Investigations Map C-81-F, scale 1:100,000.

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/pjb 2-3328-doc

Additional BLM Guidance

Off-channel CBM water containment structures will be designed to meet the following requirements and minimum standards:

1. As much as practical, the off-channel containment structure shall be located on level ground and away from established drainage patterns, including intermittent/ephemeral drainage ways, and unstable ground or depressions in the area.

2. The off-channel containment structure shall have adequate storage capacity for safe containment of all produced water, even in those periods when evaporation rates are at a minimum. Bottom dimensions must be large enough to accommodate construction equipment. The design shall provide for a minimum of two (2) feet of freeboard.

3. Depth shall be a minimum of 10 feet based on soil classification, surface terrain, evaporation, and storage requirements.

4. The containment structure levees are to be constructed so that the inside grade of the levee is no steeper than 3 (horizontal):1 (vertical), and the outside grade no steeper than 2:1[1].
5. The top of the levees shall be level and at least 12 feet wide[1].

6. The containment structure location shall be reclaimed pursuant to the requirements and standards of the surface management agency (BLM). On a split estate (private surface, Federal mineral) a surface owner's release statement or form is acceptable.

7. Fencing may be required on a case-by-case basis, determined through the pre-approval on-site inspection and NEPA analysis or if there is no beneficial use.

Notes:
[1] Design criteria may be changed by BLM Civil Engineer.

Operators must include as part of the WMP, detailed evidence that any off-channel CBM-produced water containment structure will function in a manner that will facilitate the containment, infiltration, and evaporation of the Federally-produced CBM water and resulting in minimal environmental impact.

Required data will include, but is not limited to: Depth to nearest confining layer; depth to uppermost shallow aquifer and aquifer water quality; average monthly evaporation and precipitation; and evidence that impounded water will not enter 'waters of the state'.

Off-channel containment structures will be sited in accordance with the criteria required by the WDEQ. If the off-channel containment structure is located on fee or state leases it will be regulated by the WOGCC. If the off-channel containment structure is constructed on Federal surface or on private surface/Federal mineral, the BLM is the regulating agency.

A hydrologic watershed analysis, based on field reconnaissance, must be Completed.